Decolorization of Annatto in Cheddar Cheese Whey

Abstract

A simple and effective method of decolorizing annatto-containing Cheddar cheese whey before drying is described. Annatto is easily decolorized by oxidation by both benzoyl peroxide and hydrogen peroxide. While several combinations of peroxides and heat were acceptable, .002% (w/v) benzoyl peroxide added to whey with holding at 60-63 C for one hour gave good results. The strong intensity of oxidized flavor resulting from this treatment disappeared during the drying procedure.

Cheddar cheese whey, colored with annatto, is frequently used in food manufacturing. Fifteen per cent of the annatto added to the cheese milk remains in the whey (1). The color may be highly objectionable in the dried whey and for some food uses a practical means of decolorizing it is needed. Because of its unsaturated structure, annatto is susceptible to oxidation and is easily decolorized (2). This paper reports the decolorizing effects of two oxidizing agents, benzoyl peroxide and hydrogen peroxide, on the annatto in Cheddar cheese whey.

Materials and Methods [2]

[2] Reference to certain products or companies does not imply an endorsement by the Department over others not mentioned.

Whey. In most trials, commercial annatto cheese coloring was added to milk at the rate of 60 cc/kg, the probable maximum used in industry. The colored milk was conventionally made into Cheddar cheese on laboratory and pilot plant scales. Noncolored milk served as a control to obtain noncolored whey. All whey was pasteurized to prevent additional acid formation during the decolorizing studies.

Oxidants. A commercial bleaching agent, Novadelox SS, containing benzoyl peroxide (C_6H_5CO) was compared with commercial hydrogen peroxide (H_2O_2). Appropriate amounts of each were added to annatto-containing whey to yield concentrations of .002 and .001% for (C_6H_5CO) 202 and .05 and .03% for H_2O_2. These concentrations are within the limits allowed by federal standards for certain cheeses (5). The peroxide-treated wheys were heated at temperatures ranging from 20 to 74 C for varied periods.

Analytical methods. Aliquots of treated whey were removed at 30-minute intervals during heating and centrifuged at 25,000 rpm for five minutes to remove colloidal material and suspended casein particles. The efficiency of decolorization was determined by measuring the transmittance of light by the clarified whey with a Bausch and Lomb Model 340 Spectrophotometer at a wavelength of 600 mμ. Uncolored whey and unbleached colored whey served as controls. This method is valid because annatto color obeys Beer's Law (2).

Flavor evaluation of dried decolorized whey. Several lots of whey were decolorized at 52 and at 63 C for one and one-half hours with .002 and .001% $(C_6H_5CO)_2O_2$ and with .05 and .03% H_2O_2. Catalase was added to those lots containing H_2O_2 to inactivate residual H_2O_2. The decolorized wheys were concentrated under vacuum at 48.8 C in a rotating glass laboratory evaporator and freeze-dried. A large-scale, pilot-plant drying procedure also was employed. One lot of whey was decolorized with .002% $(C_6H_5CO)_2O_2$ at 63 C for one hour. Another lot, the control, was not decolorized. They were concentrated to 45% total solids in a Wiegand-type falling-film evaporator and spray dried at 132.2 C in a Grey-Jensen dryer, using CO_2 gas injection (4). Although CO_2 gas injection was used in this study, compressed air gave the same results. The oxidative capabilities of the compressed air alone were insufficient to decolorize annatto. The resulting dried wheys were packaged in plastic bags and stored at 4.4 C. Samples from each lot were reconstituted to 10% solids and evaluated for flavor at intervals of 7, 30, and 60 days by an expert taste panel.

Results and Discussion

Representative results of decolorization studies are summarized in Table 1. Although both $(C_6H_5CO)_2O_2$ and H_2O_2 were effective bleaching agents, the former was somewhat more effective at all temperatures. As expected, the rate and extent of decolorization were increased as the temperature was raised from 32.2 to 63 C. However, there was no additional increase at 74 C, and protein denaturation was evident.

A comparison of the rates of decolorization of wheys containing 30 and 60 cc of annatto per 454 kg of milk showed no significant difference and results are not included in this table. The decolorizing effectiveness of H_2O_2 was reduced as amounts of curd particles in the whey increased, probably because of inactivating natural peroxidases in the protein. Apparently, sufficient amounts of H_2O_2 must be added to overcome the natural peroxidase before oxidation of annatto can be effective. This

[1] Deceased July 9, 1967.

TABLE 1
Effect of treatment on decolorization of whey

Treatment			Transmittance—%[a]		
Variable	Concentration	Temp	0.5	1.0	2.0
	(%)	(C)	(hr)		
Control—no color	0	52	100	100	100
Control—colored	0	52	66	68	69
$(C_6H_5CO)_2O_2$	.002	32.2	70	78	98
$(C_6H_5CO)_2O_2$	.002	52	82	91	100
$(C_6H_5CO)_2O_2$	.002	63	87	98	100
$(C_6H_5CO)_2O_2$	.002	74	86	99	100
$(C_6H_5CO)_2O_2$	.001	32.2	69	71	88
$(C_6H_5CO)_2O_2$	.001	52	79	84	94
$(C_6H_5CO)_2O_2$	.001	63	82	91	100
H_2O_2	.05	32.2	71	74	96
H_2O_2	.05	52	83	90	100
H_2O_2	.05	63	87	96	100
H_2O_2	.05	74	82	86	90
H_2O_2	.03	32.2	70	75	80
H_2O_2	.03	52	74	81	98
H_2O_2	.03	63	78	84	96

[a] Of serum after centrifugation—25,000 rpm—5 min.

would account for only moderate success in attempts to decolorize whey after vacuum concentration.

Table 2 summarizes the effects of various decolorizing and drying procedures on flavor of dried whey. Oxidized flavor intensities in the whey immediately after treatment were generally strong. Some improvement occurred during laboratory concentration and freeze drying. All traces of oxidized flavor disappeared during the pilot plant concentration and spray-drying process. This is obviously due to higher drying temperatures and the deodorization capabilities of the equipment. In view of this work, the authors believe that oxidized flavor development in decolorized whey will present no problem when spray dried by conventional methods.

This study indicates that several combinations of treatment for decolorizing whey are acceptable, with the choice depending upon facilities available, time schedules, and individual preferences. One procedure which gives good results is as follows: Pump the whey into a holding tank and warm to 60-63 C. Add .002% (w/v) Novadelox SS and hold for one hour. The whey is then ready for concentration and drying with no additional treatment. The oxidized flavor present at this stage is volatile and will disappear during drying. In case H_2O_2 is preferred, the same procedure may also be followed except that after heating, the whey is cooled to 32.2 C and catalase is added to inactivate the H_2O_2.

Oxidation with bleaching agents appears to be an efficient and satisfactory means of decolorizing annatto coloring in cheese whey. The process is relatively simple and can be used to obtain noncolored dried whey for use in foods.

References

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(4) Hanrahan, F. P., and Webb, B. H. 1961. USDA Develops Foam-Spray Drying. Food Eng., 33: (8) 37.

(5) U.S. Food and Drug Administration. 1952. Cheeses and Cheese Products, Definitions and Standards. 21 CFR Sec. 19.500(e) (III) and Sec. 19.540(c) (I).

TABLE 2
Oxidized flavor intensity in whey powder decolorized by peroxides

Treatment				Degree of oxidation[c]			
Variable	Concentration (%)	Temp (C)	Time (hr)	Fluid whey	1	30 (days)	60
Control—no color	0	52	1.5	0	0	0	+
Control—colored	0	52	1.5	0	0	0	+
$(C_6H_5CO)_2O_2$	.002	52	1.5	++++	++	++++	++++
$(C_6H_5CO)_2O_2$	.002	63	1.5	++++	+++	++++	++++
$(C_6H_5CO)_2O_2$	.001	52	1.5	+++	+	++++	++++
$(C_6H_5CO)_2O_2$	.001	63	1.5	+++	++	++++	++++
H_2O_2	.05	52	1.5	++	+	++	+++
H_2O_2	.05	63	1.5	++	+	++	++
H_2O_2	.03	52	1.5	+	0	+	++
H_2O_2	.03	63	1.5	++	0	+	+++
Sample A[a]	0	63	1	0	0	0	+
Sample B[b]	.002	63	1	++++	0	0	+

[a] Pilot plant spray-dried powder—control.
[b] Pilot plant spray-dried powder—$(C_6H_5CO)_2O_2$-treated.
[c] 0 = None. + = Slight. ++ = Easily noticeable. +++ = Strong. ++++ = Intense.